

UNDERSTANDING AND USING THE HVAC DESIGN REVIEW FORM

Load Calculation: Manual J
Equipment Selection: Furnace and Air Conditioner

The form below illustrates the Manual J forms and the equipment selection process for a furnace and air conditioner. The circled numbers on HVAC Systems Design Review Form correspond to the description in the instructions and to the locations where the information can be found on the supporting documentation.


 Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts)		Form RPER 1 15 Mar 09
County, Town, Municipality, Jurisdiction Header Information		
Contractor <u>ABC Heating and Air Conditioning Company</u> Mechanical License # <u>MCL# 123456789</u> Building Plan # <u>Model P987654321, dated 1 June 2008</u> Home Address (Street or Lot#, Block, Subdivision) <u>123 Elm Street, Ames, Iowa</u>		REQUIRED ATTACHMENTS Manual J1 Form (and supporting worksheets): Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> or MJ1AE Form* (and supporting worksheets): Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> OEM performance data (heating, cooling, blower): Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Manual D Friction Rate Worksheet: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Duct distribution system sketch: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
HVAC LOAD CALCULATION (IRC M1401.3)		
Design Conditions Winter Design Conditions Outdoor temperature <u>1</u> <u>2</u> <u>-6</u> °F Indoor temperature <u>14</u> <u>70</u> °F Total heat loss <u>59,326</u> Btu Summer Design Conditions Outdoor temperature <u>3</u> <u>90</u> °F Indoor temperature <u>4</u> <u>75</u> °F Grains difference <u>5</u> <u>38</u> Δ <u>6</u> <u>50</u> % Rh Sensible heat gain <u>15</u> <u>23,807</u> Btu Latent heat gain <u>16</u> <u>4,771</u> Btu Total heat gain <u>28,578</u> Btu		Building Construction Information Building Orientation (Front door faces) <u>North</u> North, East, West, South, Northeast, Northwest, Southeast, Southwest Number of bedrooms <u>3</u> Conditioned floor area <u>9</u> <u>1,792</u> Sq Ft Number of occupants <u>10</u> <u>4</u> Windows Eave overhang depth <u>2</u> Ft Internal shade <u>Blinds, light, 1/2 Closed</u> Blinds, drapes, etc. Number of skylights <u>2</u>
HVAC EQUIPMENT SELECTION (IRC M1401.3)		
Heating Equipment Data Equipment type <u>Gas Furnace</u> Furnace, Heat pump, Boiler, etc. <u>19</u> Model <u>XYZ 080-14</u> Heating output capacity <u>20</u> <u>64,000</u> Btu Heat pumps - capacity at winter design outdoor conditions Auxiliary heat output capacity <u>N/A</u> Btu	Cooling Equipment Data Equipment type <u>22</u> <u>Air Conditioner</u> Air Conditioner, Heat pump, etc. Model <u>23</u> <u>XYZ 030 Condenser 030 Cooling Coi</u> Latent cooling capacity <u>7,900</u> Btu Sensible cooling capacity <u>25</u> <u>21,400</u> Btu Total cooling capacity <u>26</u> <u>29,300</u> Btu	Blower Data Heating CFM <u>1,117</u> CFM Cooling CFM <u>28</u> <u>1,000</u> CFM Static pressure <u>29</u> <u>0.75</u> IWC Fan's rated external static pressure for design airflow
HVAC DUCT DISTRIBUTION SYSTEM DESIGN (IRC M1601.1)		
Design airflow <u>30</u> <u>1,117</u> CFM Equipment design ESP <u>31</u> <u>0.75</u> IWC Component Pressure Losses <u>32</u> <u>0.40</u> IWC Available Static Pressure <u>33</u> <u>0.35</u> IWC	Longest supply duct <u>34</u> <u>278</u> Ft Longest return duct <u>35</u> <u>110</u> Ft Total Effective Length <u>36</u> <u>388</u> Ft Friction Rate: <u>37</u> <u>0.9</u> IWC <small>Friction Rate = (ASP × 100) ÷ TEL</small>	Duct Materials Used (circle) Trunk Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify) Sheet metal (insulated R-8) Branch Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify) Flex duct (insulated R-8)
I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above. I understand the claims made on these forms will be subject to review and verification.		
Contractor's Printed Name <u>Bartholomew J. Simpson</u>		Date <u>1 April 2009</u>
Contractor's Signature _____		
Reserved for County, Town, Municipality, or Authority having jurisdiction use.		
<small>* Home qualifies for MJ1AE Form based on Abridged Edition Checklist.</small>		

Figure 1: Sample Completed HVAC System Design Review Form – Manual J

Part I: Manual J – Forms used for Load Calculations

Worksheet A Location and Design Conditions			
State: Iowa	City: Ames (2)	Elevation = 955 Ft	Latitude = 42 Degrees North
Indoor Conditions, Heating: DB = 70 °F RH = 20%		Indoor Conditions, Cooling: DB = 75 °F RH = 50%	
Table 1 Conditions	99% DB = -6 °F	1% DB = 90 °F	Grains Difference = 38
Design Temperature Differences (1)		HTD = 7 (3) = 76 °F	D = 90 - 75 = 15 °F (5)
		Daily (4) Age = Medium (6)	

Form J1

1 Name of Room		Smith Residence		Entire House								
2 Running Feet of Exposed Wall				2 x (56 + 32) = 176								
3 Ceiling Height (Ft) and Gross Wall Area (SqFt)				8 & 10		1,408 + 696 = 2,104						
4 Room Dimensions (Ft) and Floor Plan Area (SqFt)				56 x 32		(9) 1,792						
5 Ceiling Slope (Deg.) and Gross Ceiling Area (SqFt)				0		1,792						
Type of Exposure	Const. Number	Panel Faces	HTM		Area or Length	Btuh			Area or Length	Btuh		
			Htg.	Clg.		Heating	S-Clg.	L-Clg.		Heating	S-Clg.	L-Clg.
6a	Windows and Glass Doors	a	Unit A = 1G	N	37.24	11.09	43.75	1,629	485			
		b	Unit A = 1G	E / W	37.24	37.10	43.75	1,629	1,623			
		c	Unit B = 1G	N	33.44	11.16	14.00	468	156			
		d	Unit B = 1G	S	33.44	15.81	28.00	936	443			
		e	Unit C = 1G	W	41.04	39.63	58.00	2,380	2,299			
		f	Unit D = 1G	S	41.04	17.30	47.13	1,934	815			
		g	Unit E = 1G	N	31.92	12.58	10.31	329	130			
		h	Unit E = 1G	S	31.92	22.88	10.31	329	236			
		i										
		j										
6b	Skylights	a	Unit 1 = 8G	N	98.42	100.75	8.00	787	806			
		b	Unit 2 = 8G	S	68.97	92.94	32.00	2,207	2,974			
		c										
7	Wood and Metal Doors	a	11N	(7)	26.60	9.1	21.0	559	191			
		b	11N		26.60	9.1	21.0	559	191			
		c										
8	Above Grade Walls and Partitions	a	14A-8		6.92	1.16	1,207	8,347	1,395			
		b	15A-4sffc wall		10.41	2.10	600	6,246	1,257			
		c	15A-4sffc part		0.90	0.18	96	87	17			
		d										
		e										
		f										
		g										
9	Below Grade Walls	a	15A-4sffc-4		6.00		284	1,705				
		b	15A-4ffc-8		4.71		224	1,055				
		c										
10	Ceilings	a	16B-30ad		2.43	1.60	1,752	4,261	2,803			
		b										
		c										
11	Floors	a	19B-osp		2.43	0.48	736	1,788	352			
		b	22B-5ph		44.76		64	2,865				
		c	21A-32		1.52		544	827				
		d										
12	Infiltration	Heating Load (Btuh)		Effect ACH	0.408	WAR	11,237	1,054	1,651	WAR		
		Sensible Load (Btuh)										
		Latent Load (Btuh)										
13	Internal	a	Occupants at 230 and 200 Btuh		4	(10)	920	800				
		b	Scenario Number 1									
		c	Default Adjustments None									
		d	Custom Appliances NA									
		e	Plants None									
14	Subtotals	Sum lines 5 through 12				52,164	20,548	2,451				
15	Duct Loads	EHLF & ESGF		0.049	0.026		2,561	530	565			
		ELG										
16	Ventilation Loads	Vent Cfm	70	E Cfm	70		1,987	459	1,755			
17	Winter Humidification Load	Gal / Day		7.1		2,614						
18	Piping Load											
19	Blower Heat											
20	AED Excursion & Latent Moisture Migration Load					(14)	(15)	(16)				
21	Total Load	Sum Lines 13 Through 19				59,326	23,807	4,771				

Figure 2: J1 Worksheets A and Form J1

Part II: Manual S – Equipment Expanded Performance Data

XYZ Furnace Company (19)

MODEL	060 - 14	080 - 14	080 - 16
TYPE	Downflow / Horizontal	Downflow / Horizontal	Downflow / Horizontal
RATINGS			
Input BTUH	60,000	80,000	80,000
Capacity BTUH (ICS)	48,000	64,000 (20)	64,000
AFUE	80.0	80.0	80.0
Temp. rise (Min.-Max.) °F.	30 - 60	35 - 65	35 - 65

Figure 3: Furnace Performance Data

Based on the heating output and temperature rise (TR) limitations the airflow should be about 1,185 CFM, based on: $\text{CFM} = 64,000 \div (50^\circ\text{F} \times 1.1 \times 1.0) = 1,185 \text{ CFM}$

$\text{CFM} = \text{Btu} \div (\text{TR} \times 1.1 \times \text{ACF})$ where:

CFM: Cubic Feet per Minute, the volume of air moving through the equipment

Btu/h: The heating capacity of the furnace or other heat source. The XYZ 80-14 has an output capacity of 64,000 Btu.

1.08: A physics constant that converts pounds of air to a volume of air.

ACF: Altitude Correction Factor, for homes at elevations above 1,000 feet. Ames Iowa elevation is 955 ft. therefore, the ACF is 1.0.

For the air conditioner, below, the outdoor design temperature for this example is 90°F, this designer interpolated the value between the 85°F and the 95°F cooling performance values. In these situations, one could verify the math, or “eyeball” the listed capacity and ensure it falls within the other two capacities listed. Verifying the math may be of value however, the important element to verify is that the cooling equipment does not exceed the capacity limitations.

The Latent capacity was determined by subtracting the Sensible capacity from the Total capacity (29,300 – 21,400 = 7,900).

Note the air flow required to deliver the capacities stated (1,000 CFM).

XYZ Performance Data (28)						
Model 030 with Coil AC030 and Furnace FR 080-14 @ 1,000 CFM						
OD Dry Bulb (F)	Indoor Entering Wet Bulb (F)	Total Capacity	Sensible Capacity at Entering Dry Bulb Temperature (F)			
			72	75	78	80
85	59	28,400	22,600	25,300	27,800	29,400
	63	29,900	18,800	21,600	24,300	26,100
	67	32,100	15,100	17,900	20,700	22,600
	71 (26)	34,700	11,400	14,200 (25)	17,000	18,900
95	59	27,300	22,200	24,900	27,400	28,300
	63	28,700	18,500	21,200	23,900	25,700
	67	30,800	14,700	17,500	20,400	22,200
	71	33,300	11,000	13,700	16,600	18,500
105	59	26,200	21,900	24,500	27,100	27,200
	63	27,600	18,100	20,900	23,600	25,400
	67	29,700	14,300	17,200	20,000	21,800
	71	32,100	10,600	13,300	16,200	18,100

OD Dry Bulb – Outdoor Dry Bulb, the outdoor temperature.

Correction Factors for other Airflows			
	Airflow	Total Capacity	Sensible Capacity
Low	875	0.98	0.93
High	1125	1.02	1.06
Multiply rated capacity data by factor.			

Figure 4: Air Conditioner's Expanded Performance Data

The XYZ FR 08-14 blower assembly can deliver approximately 1,117 CFM on Med-Lo fan speed and 1,000 CFM on Low fan speed. 1,117 CFM is an acceptable amount of airflow for the furnace (this equates to a 53°F TR), and 1,000 CFM is the volume of air necessary for the cooling system.

XYZ Furnace Company Blower Data										
Air Delivery – CFM (with filter)										
Unit Size	Return Air Entry	Fan Speed	External Static Pressure (inches water column)							
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
FR 060-14	1 side or bottom	High	1100	1065	1005	945	900	805	730	610
		Med-Low	890	865	810	765	705	620	540	475
		Low	745	710	670	625	565	505	425	360
FR 080-14	1 side or bottom	High	1740	1705	1660	1615	1570	1500	1425	1355
		Med-High	1500	1470	1445	1410	1375	1330	1280	1210
		Med-Low	1340	1315	1300	1270	1235	1200	1140	1095
		Low	1195	1175	1165	1130	1100	1070	1030	975
FR 080-16	1 side or bottom	High	2250	2175	2090	2020	1930	1855	1760	1670
		Med-High	2020	1950	1900	1840	1790	1710	1640	1545
		Med-Low	1725	1690	1660	1630	1575	1520	1460	1370
		Low	1490	1480	1460	1440	1380	1340	1295	1230
‡ • Airflow shown is for bottom only return-air supply with factory supplied 1-in. washable filter (0.05 IWC).										

Figure 5: Blower Performance Data

Part III: Manual D Duct Sizing

Friction Rate Worksheet

Step 1) Manufacturer's Blower Data

External static pressure (ESP) = 0.75 IWC Cfm = 1,117

Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	<u>0.18</u>
Electric resistance heating coil	<u> </u>
Hot water coil	<u> </u>
Heat exchanger	<u> </u>
Low efficiency filter	<u> </u>
High or mid-efficiency filter	<u>0.13</u>
Electronic filter	<u> </u>
Humidifier	<u> </u>
Supply outlet	<u>0.03</u>
Return grille	<u>0.03</u>
Balancing damper	<u>0.03</u>
UV lights or other device	<u> </u>

Total component losses (CPL) = 0.40 IWC

Step 3) Available Static Pressure (ASP)

ASP = (ESP - CPL) = (0.75 - 0.40) = 0.35 IWC

Step 4) Total Effective Length (TEL)

Supply-side TEL + Return-side TEL = (278 + 110) = 388 Feet

Step 5) Friction Rate Design Value (FR)

FR value from friction rate chart = 0.09 IWC/100

$$FR = \frac{ASP \times 100}{TEL}$$

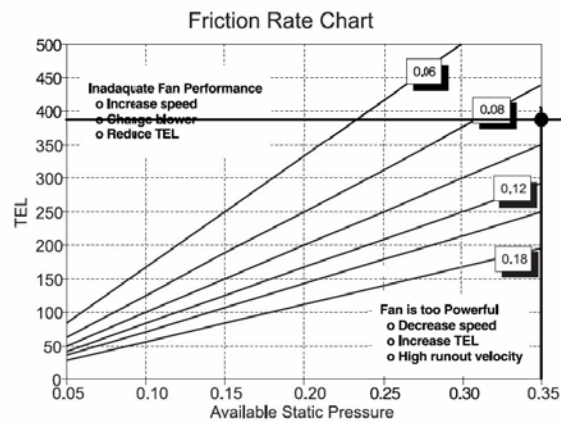


Figure 6: Example Friction Rate Worksheet